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COMPETITION BETWEEN LINSEED AND OTHER DRYING OILS, WITH PARTICULAR REFERENCE TO CALIFORNIA

by

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and

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Ernest W. Grove [2] and Dallas W. Smythe [3]

INTRODUCTION

California has been making rapid strides in the production of flaxseed in the last three years. In 1934 when flaxseed first became commercially important in this state, 242,000 bushels were produced on 11,000 acres. In that year California ranked seventh in the United States in acreage and fourth in production. The following year California rose to sixth place in acreage with 38,000 acres on which 570,000 bushels were produced. For 1936, though the estimated acreage of 43,000 is not a large increase over that for 1935, a considerably larger total production is expected. The August 1 estimate was for a production of 731,000 bushels.

During this period when flaxseed was becoming an important California crop, linseed oil, the major product of flaxseed, was declining in relative importance in the group of drying oils now used industrially in this country. This study has been undertaken with a view to providing fuller information concerning these changes in the drying oil situation. Several other drying oils have been of increasing importance in the United States in recent years, and the decline in relative importance of linseed oil is in part a result of increased competition from these other oils, some of which are imported, while others are being produced domestically in increasing quantities. In the approximate order of their importance during recent years these competing oils are tung or chinawood oil, perilla oil, fish oils, soybean oil, hempseed oil, and some others as yet insignificant. In the paint and varnish industry, the linoleum and oilcloth industry, and the printing ink industry, which together account for 97 per cent of the annual consumption of linseed oil, the above-mentioned oils have been increasingly important since 1929. This increase has been, in part, a result of price relationships and, in part, a result of new chemical techniques which have increased the usability of certain oils.

To understand the nature and significance of the recent changes it will be helpful to consider briefly the longer-term trends in the linseed oil industry which has always been a major factor in the drying-oil industries of the United States. Until 1908 the United States was an exporter of flaxseed. Since that date this coultry has been a deficiency producer of this commodity and has usually imported large quantities. The United States production and net supply since 1902 are shown graphically in figure 1. The changes during the shorter period, 1929-1934, with which we are here mainly concerned are shown in figure 2. The growing importance of the other drying oils mentioned above is evident from the latter graph. Although the actual consumption [4] of linseed oil has fluctuated in response to conditions

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[1] The authors wish to acknowledge the assistance rendered by officials in the Federal-State Market News Service, U. S. Dept. Agr., U. S. Bur. of For. and Dom. Commerce, U. S. Tariff Commission, and by certain California oil-seed crushing companies. Dr. M. R. Benedict and Dr. H. E. Erdman of the Giannini Foundation also assisted in planning the study and in reviewing the manuscript.

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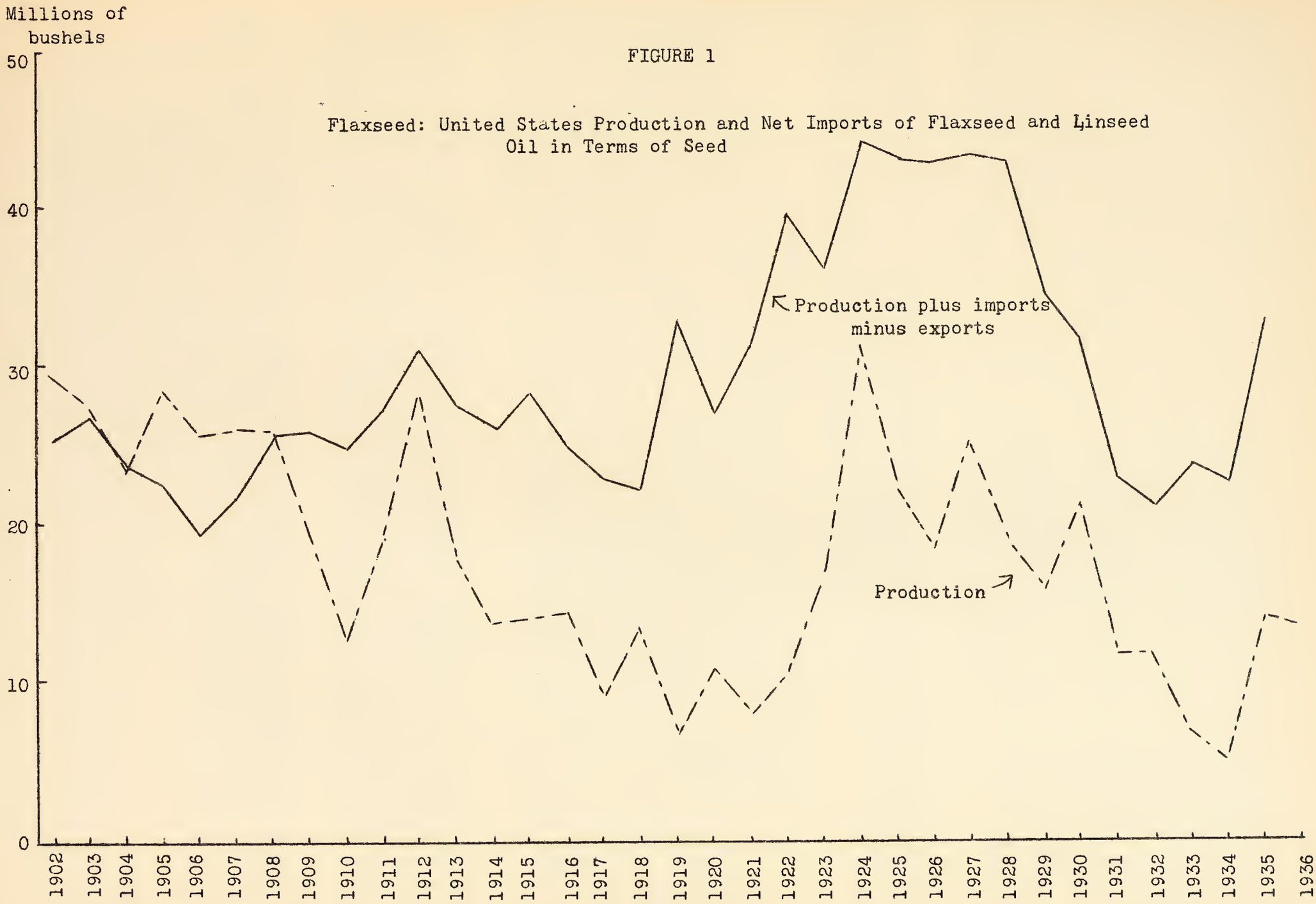
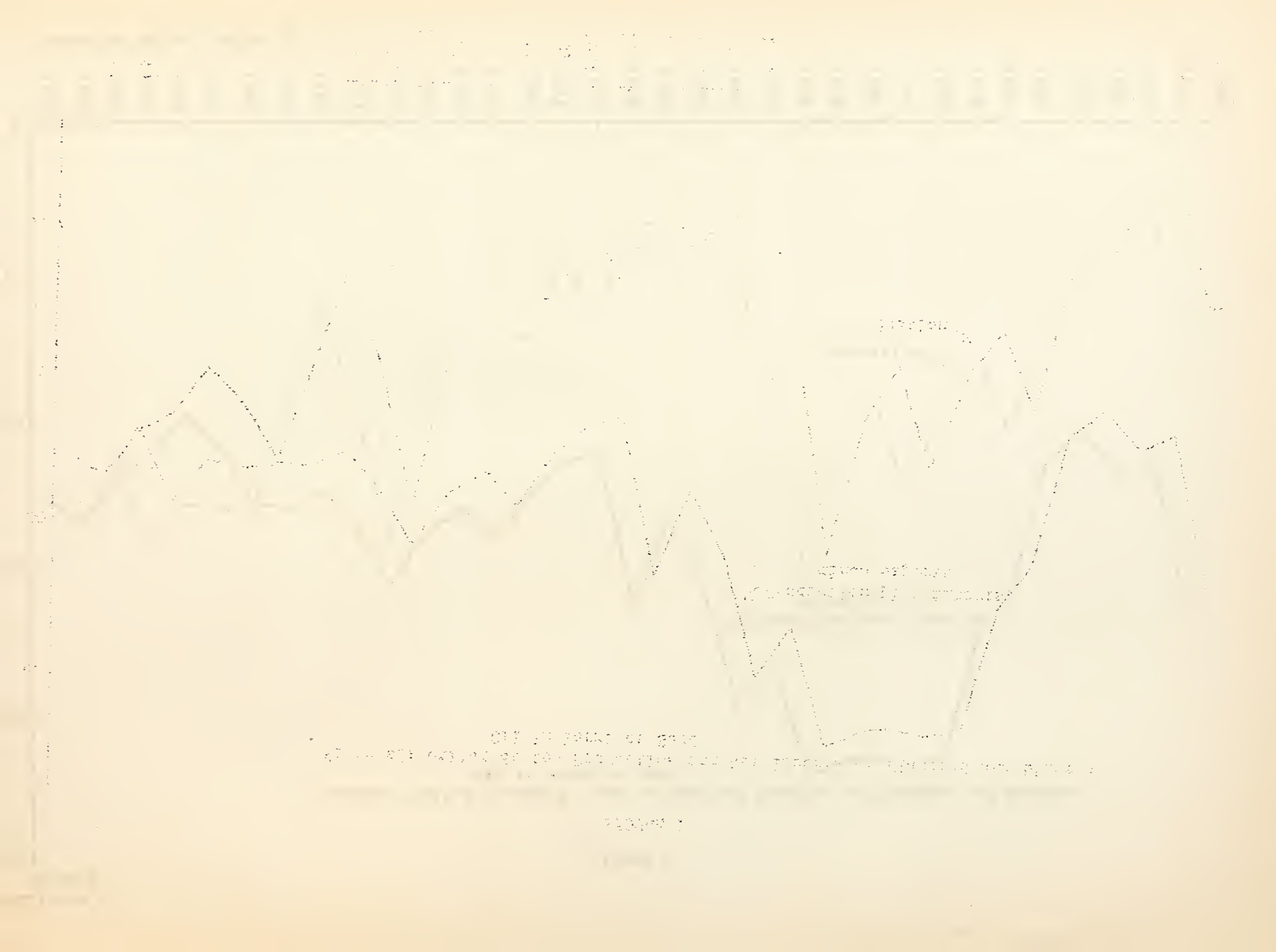
[4] These figures refer to factory consumption only.

FIGURE 1

Flaxseed: United States Production and Net Imports of Flaxseed and Linseed Oil in Terms of Seed



Source of data: Table 8.



of prosperity and depression, its consumption as compared to the total consumption of oils in the industries indicated above has declined continuously during the period 1929 to 1935. In 1931, 291,000,000 pounds of linseed oil were consumed. In 1932 consumption fell to 215,000,000 pounds. Thereafter it rose steadily in the ensuing years until, in 1935, 287,000,000 pounds were consumed. Thus the consumption in 1935 was almost up to the 1931 level, but it was only 57 per cent of the total oil consumption for that year, as compared to 70 per cent for the year 1931. The other side of this picture is the relative increase in the consumption of other oils. Perilla oil, which increased from less than one half of 1 per cent in 1929 to 7.5 per cent in 1935, has had the most rapid growth. The others have also increased, however. These changes are undoubtedly due, in part, to world-wide disturbances in price conditions, business activity, and foreign trade conditions during this period. There appear to be, however, other reasons for the changes in relative usage. These are discussed in the following pages.

This discussion of the problem undertakes merely to provide a clear view of the recent trends in flaxseed and linseed oil production and consumption, and to show the changes in consumption of other drying oils and the main reasons therefor. Consideration of the technical and farm-management limitations or possibilities of flaxseed culture are outside the scope of this study.

Production and Consumption of Flaxseed in the United States

Flax may be grown for fiber or for seed, or for both. However, since the type of plant and method of cultivation differ according to the purpose, it is not customary to produce for both seed and fiber. "Cultivation for fiber requires harvesting before the seed is fully ripe, reducing the quantity and quality of the flaxseed." [5] In the United States, flax cultivation is almost entirely for seed, although a small amount of flax for fiber is produced in Oregon, a "retting and scutching" plant being operated at the State Penitentiary at Salem. Most of the Oregon fiber is made into fish-net twine, sacking twine, and crash towelling. Flax straw is also "utilized to a limited extent in flaxseed-producing areas, particularly in Minnesota, in the production of rugs, matting, towelling, insulating boards, and building paper." [6] For high-grade fabrics, however, flax fiber must be imported.

Flaxseed is crushed to produce linseed oil. Linseed cake or meal is a by-product in this process. Linseed oil is principally used in the manufacture of paints and varnishes. The cake or meal is used as a cattle feed; domestic sales being chiefly in the form of meal while exports are almost entirely in the form of cake. Flaxseed yields about one-third of its weight in oil, two-thirds in cake. The value of the linseed oil is about three-fourths of the combined values of the oil and cake. [7]

The principal flaxseed-producing area in the United States is the "West North Central District," over 90 per cent of the domestic crop being produced in this area, mostly in Minnesota, North Dakota, South Dakota, and Montana. Since

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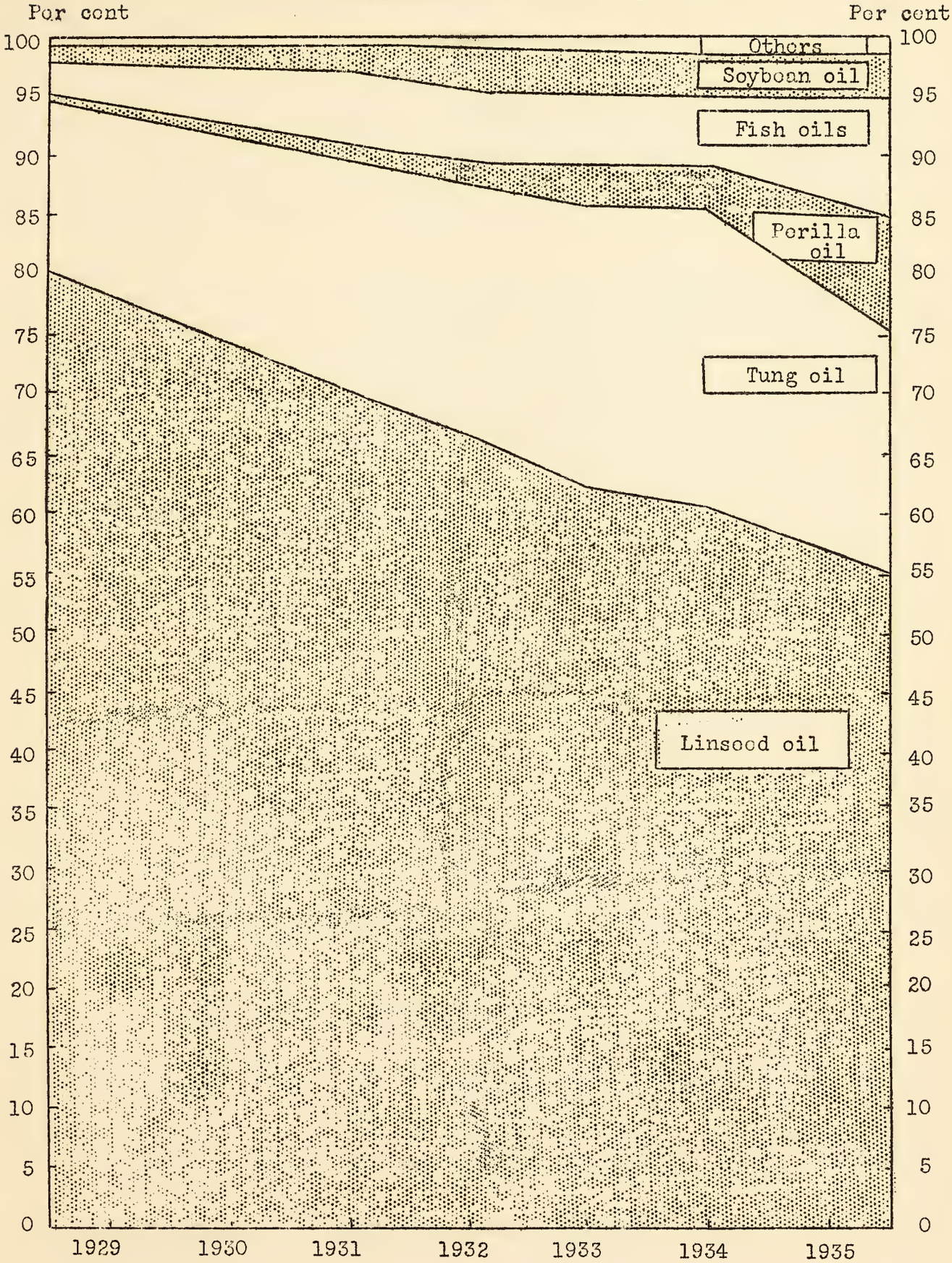
[5] Encyclopaedia Americana. Flax.

[6] U. S. Tariff Commission: Flaxseed. p. 2. 1929.

[7] U. S. Tariff Commission: Linseed oil. Supplementary report. p. 6. 1929.

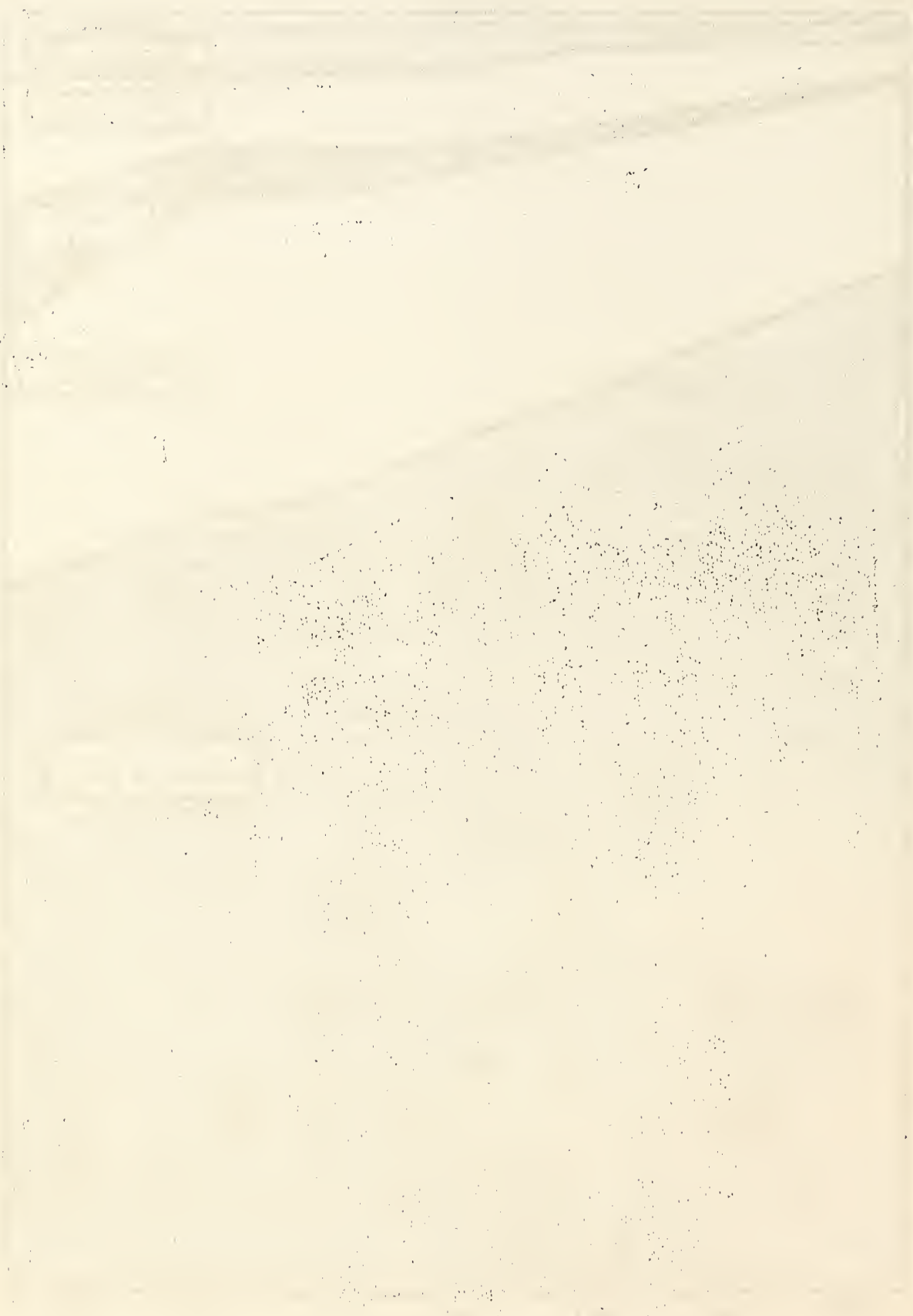
FIGURE 2

Various Drying Oils as Per Cent of
Annual Factory Consumption, United States, 1929-1935



Note: The figures for 1930 are not available, so the graph has been drawn on the assumption that the percentages for 1930 are the averages of those in 1929 and 1931.

Source of data: Table 7.



1934, however, California has replaced Montana as the fourth most important flax-producing state (table 1).

Although the United States, along with Argentina, Canada, Russia, and India, is one of the principal flaxseed-producing countries of the world, the fact that domestic production does not equal consumption necessitates the importation each year of large quantities of flaxseed. Most of the imported flaxseed comes from Argentina, 87 per cent coming from that country in the period 1930 to 1934 (table 2). Ordinarily, the second most important country of origin is Canada, but in 1934 a much larger amount came from British India.

The United States is an important country in the crushing of flaxseed, as well as in its cultivation. The other crushing countries in the order of their importance are Great Britain, the Netherlands, and Germany. These countries, however, produce little or no flaxseed, being dependent to an even greater extent than the United States on imports. There are three important crushing centers in the United States: first, the Atlantic Coast, mainly in New York, New Jersey, and Pennsylvania; second, western New York and Ohio, mainly in Buffalo; and third, the Middle West, mainly in Minneapolis, St. Paul, and Chicago.[8] On the Pacific Coast the crushing establishments are dependent on other imported oil seeds as well as flaxseed. California has twenty-one vegetable seed-crushing plants, of which eleven are in southern California, five around San Francisco Bay, and five in the San Joaquin Valley. In normal years, mills on the Atlantic Coast crush imported Argentine seed; mills in the Minneapolis-Chicago region crush domestic seed and imported Canadian seed, which is grown just across the border from the flax-growing area in the United States; and mills at Buffalo crush seed from all of these sources. When the domestic and Canadian crop is large some of it is crushed in eastern mills; when it is small Argentine seed may be crushed as far west as Chicago or Milwaukee.[9]

The tariff rates on flaxseed and linseed oil from 1909 to date are given in table 3. The present tariff on linseed oil is 4.5 cents per pound. That on flaxseed is 65 cents per bushel which is equivalent to a tax on the oil content of 3.5 cents per pound. This gives a differential of 1 cent per pound in favor of flaxseed. This tariff advantage for flaxseed has prevented any large imports of linseed oil in recent years. Since 1909 the tariffs have favored the American crusher and the importation of flaxseed instead of linseed oil, except for a short period in 1921 and 1922 when, under the Emergency Tariff, the differential was slightly in favor of linseed oil. It was only in these two years that linseed oil was imported in large amounts. Net imports and exports of linseed oil are presented in figure 3.

It should be noted that the differential in favor of flaxseed is increased by the re-export, with benefit of tariff drawback, of linseed cake produced from imported flaxseed. In other words, if the cake is exported, the crusher is repaid a part of the tariff equal to the proportion between the commercial value of the cake and the total value of the oil and cake. The value of the cake is usually about one-third of the value of the oil or one-fourth of the total value. Consequently, one-fourth of the duty paid will be refunded, and the effective tariff on the oil

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[8] U. S. Tariff Commission. Linseed oil. Supplementary report. p. 7. 1929.

[9] U. S. Tariff Commission. Linseed oil. Supplementary report. p. 24. 1929.

TABLE 1

Flaxseed: United States Acreage and Production by States

1932-1936

	Acreage					Production				
	1932	1933	1934	1935	1936*	1932	1933	1934	1935	1936*
	Thousand acres					Thousand bushels				
Michigan	6	8	9	9	9	63	72	90	99	86
Wisconsin	6	4	5	6	6	66	40	59	66	51
Minnesota	689	682	621	677	779	6,339	4,365	3,850	6,432	3,895
Iowa	19	28	16	18	16	171	182	96	171	128
Missouri	2	3	4	5	5	10	14	9	10	12
North Dakota	831	465	239	932	699	2,992	1,674	908	5,126	1,048
South Dakota	165	46	14	190	59	776	115	35	950	118
Nebraska	3	2	--	4	2	18	12	--	28	4
Kansas	48	38	56	58	44	312	236	280	348	198
Montana	214	64	20	76	35	749	192	92	319	70
Wyoming	5	1	--	1	1	15	2	--	4	1
California	--	--	11	38	43			242	570	731
United States	1,988	1,341	995	2,014	1,698	11,511	6,904	5,661	14,123	6,342

* Indicated for harvest, August 1, 1936.

Sources of data:

1932-1935: U. S. Dept. Agr. Bur. Agr. Econ. Crop Reporting Board. General crop revisions, crop years 1924-1935. June, 1936. (Mimeo.)

1936: U. S. Dept. Agr. Bur. Agr. Econ. Crop Reporting Board. General crop report as of August 1.

TABLE 2

Flaxseed: United States Imports by Countries of Origin

1926-27 to 1933-34

(Thousand bushels -- July to June)

Country	1926-27	1927-28	1928-29	1929-30	1930-31	1931-32	1932-33	1933-34
Argentina	20,581	16,057	20,927	19,236	6,102	13,342	5,495	12,736
Uruguay	23	0	38	0	221	0	0	503
Canada	3,566	2,025	2,528	355	1,490	506	718	176
British India	0	0	0	59	0	0	0	4,311
Others	54	30	1	2	0	2	0	175
Total	24,224	18,112	23,494	19,652	7,813	13,850	6,213	17,901

Source of data:

U. S. Dept. Agr. Yearbook 1935:658.

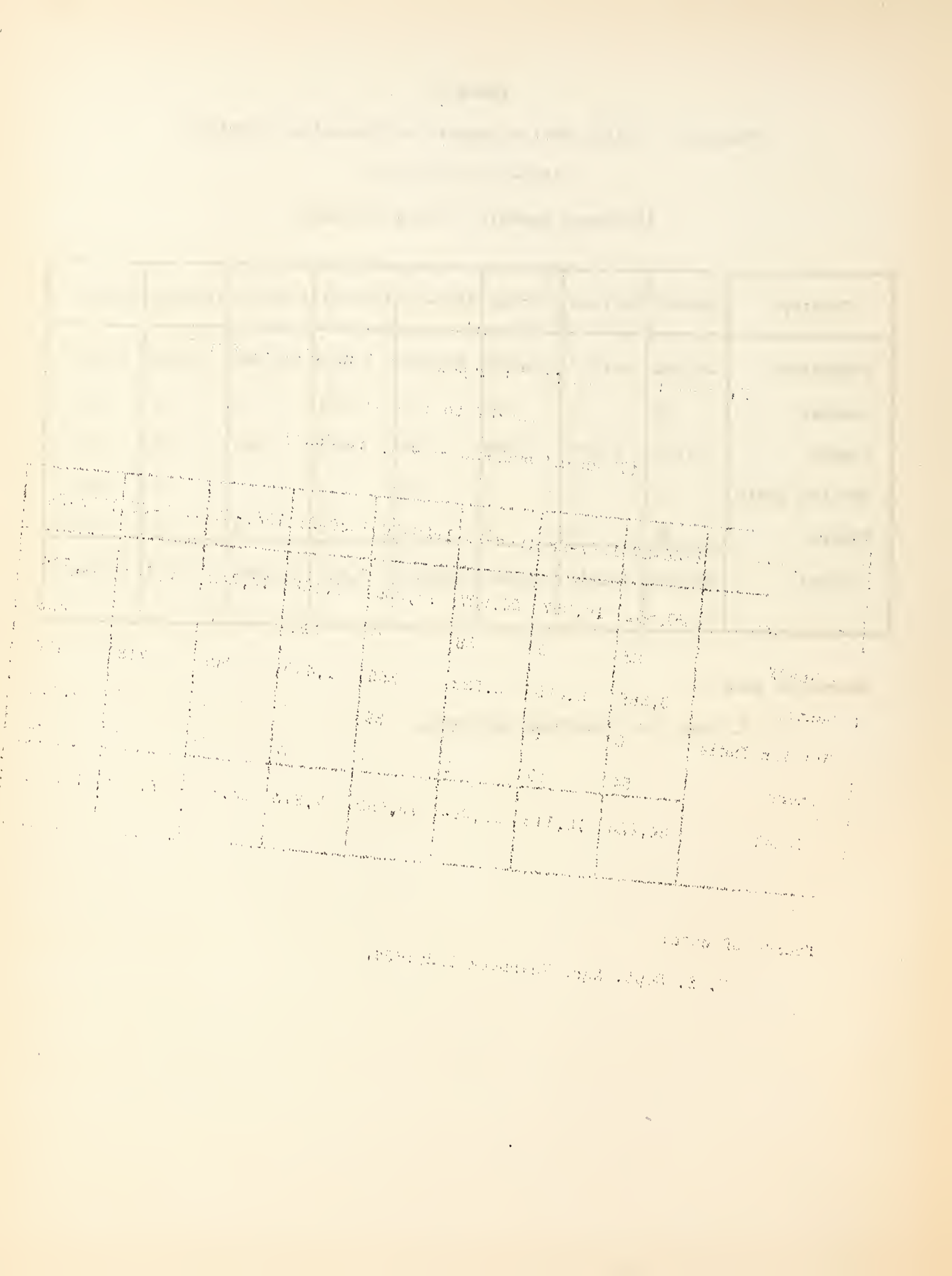


TABLE 3

Flaxseed and Linseed Oil: United States Tariff Rates

1909-1936

Name of tariff	Date passed	Flaxseed	Equivalent to a linseed oil tariff in cents per pound of *	Linseed oil †	
		cents per bushel		cents per pound	cents per gallon
Payne-Aldrich	August 5, 1909	25	1.3	2.0	15.00
Underwood-Simmons	October 3, 1913	20	1.1	1.3	10.00
Emergency	May 27, 1921	30	1.6	1.3	10.00
Fordney-McCumber	September 21, 1922	40	2.1	3.3	24.75
Flexible (subject to Presidential Proclamation)	May 14, 1929	56	3.0	3.7 ‡	27.75
Hawley-Smoot	June 17, 1930	65	3.5	4.5	33.75

* One bushel of flaxseed equivalent to 18.75 pounds of linseed oil.

† Seven and one-half pounds equals 1 gallon.

‡ Proclamation on linseed oil was dated June 25, 1929.

Sources of data:

United States Tariff Commission. Flaxseed -- report of the United States Tariff Commission to the President of the United States. pp. 1 and 64. Washington. 1929.

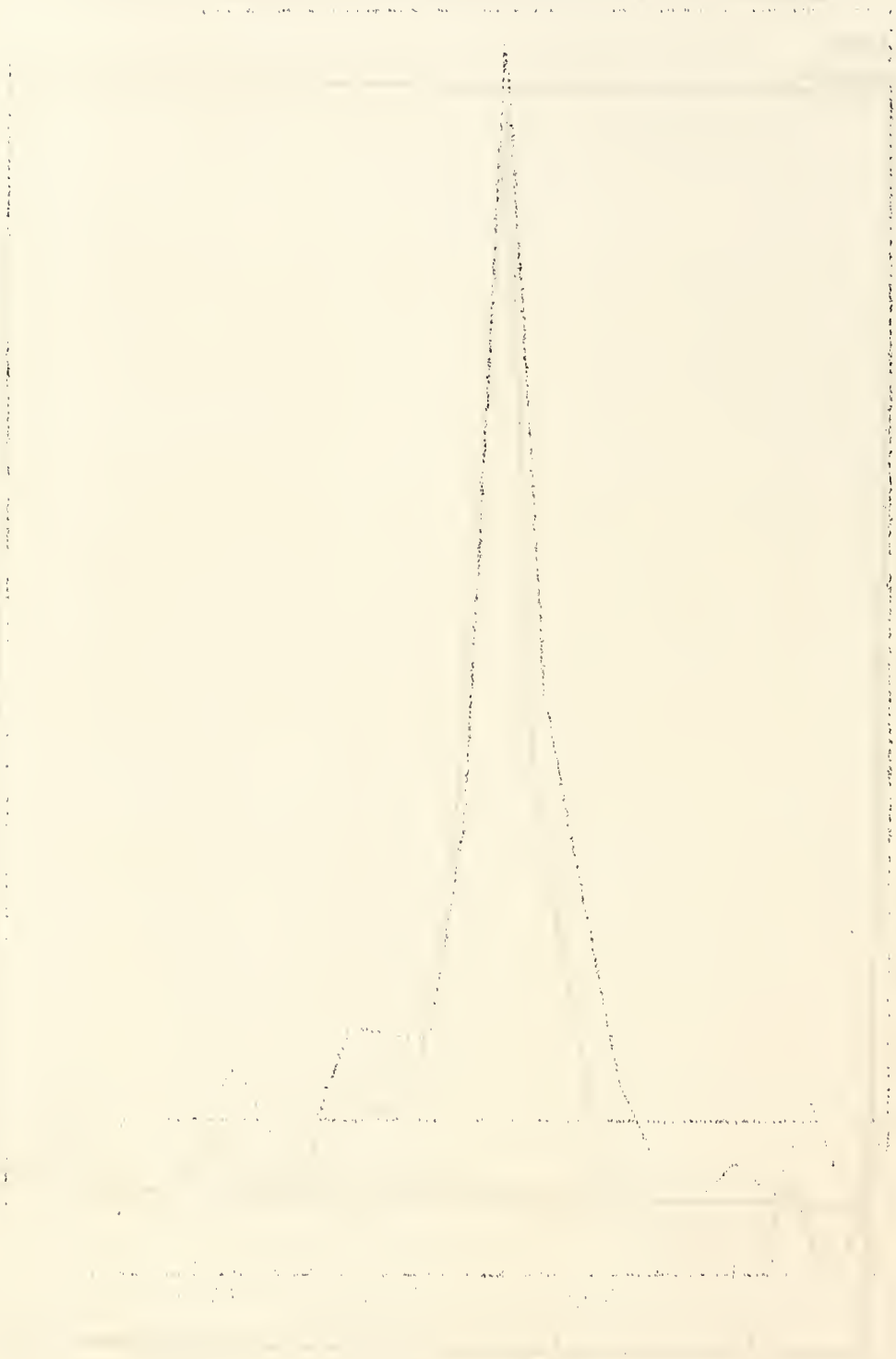
United States Tariff Commission. Linseed Oil -- report of the United States Tariff Commission to the President of the United States. pp. 2 and 66. Washington. 1929.

Comparison of Tariff Acts of 1913, 1922, and 1930, prepared for the use of the Committee on Ways and Means, House of Representatives. p. 15. Washington. 1931.

FIGURE 3

Linseed Oil: Net Imports or Exports, 1912-1935

* Plus sign equals net imports; minus sign equals net exports.
Source of data: Table 9.



yield from imported flaxseed is reduced to about three-fourths of 3.5 cents per ..nd, or 2.6 cents per pound. Approximately 71 per cent of the cake from imported flaxseed is exported with drawback. [10]

The Drying Oils

The largest use for drying oils is in the manufacture of paints, varnishes, and enamels. Less important uses are in the manufacture of linoleum and oilcloth, and in making printer's ink. For linseed oil, 79 per cent of the annual factory consumption is in the paint industry, 14 per cent in the manufacture of linoleum and oilcloth, and 4 per cent in printing inks. The remaining 3 per cent is divided among numerous minor uses, including the making of foundry oils, putty, and soft soaps.

In making paints and varnishes, oils must be used which oxidize quickly, leaving a hard, durable film. "In the order of their drying qualities, the drying oils are tung, perilla, linseed, hempseed, poppyseed, walnut, soybean, and sunflower; the semi-drying oils are sardine, menhaden, corn, whale, herring, cottonseed, and sesame. The semi-drying oils ....can be used in this industry only to a minor extent, and the drying oils vary greatly in usability." [11]

The "iodine value," or "iodine number," of an oil represents the amount of iodine a given quantity of the oil will absorb under certain specified conditions. The ability of an oil to absorb iodine is associated with its power to absorb oxygen; and, since the drying quality of an oil is generally dependent on its ability to absorb oxygen, the iodine value is a rough index of an oil's suitability for use in paints and varnishes. Thus the oils with the highest iodine values dry most quickly, and form the hardest films. The iodine value for any oil will vary with different samples of the oil and with the method of testing. The range in iodine values for each of the important oils is listed below. [12]

Iodine Value

Oil	Range	Average
1. Perilla	181-207	194
2. Linseed	170-205	188
3. Sardine	161-192	177
4. Oiticica	155-179	167
5. Menhaden	139-193	166
6. Tung	149-176	162
7. Hempseed	140-166	153
8. Lumbang (Candlenut)	140-164	152
9. Walnut	132-162	147
10. Poppyseed	133-158	146
11. Safflower	140-150	145
12. Soybean	124-143	134
13. Whale	110-147	129
14. Sunflower	119-136	127
15. Herring	103-142	123

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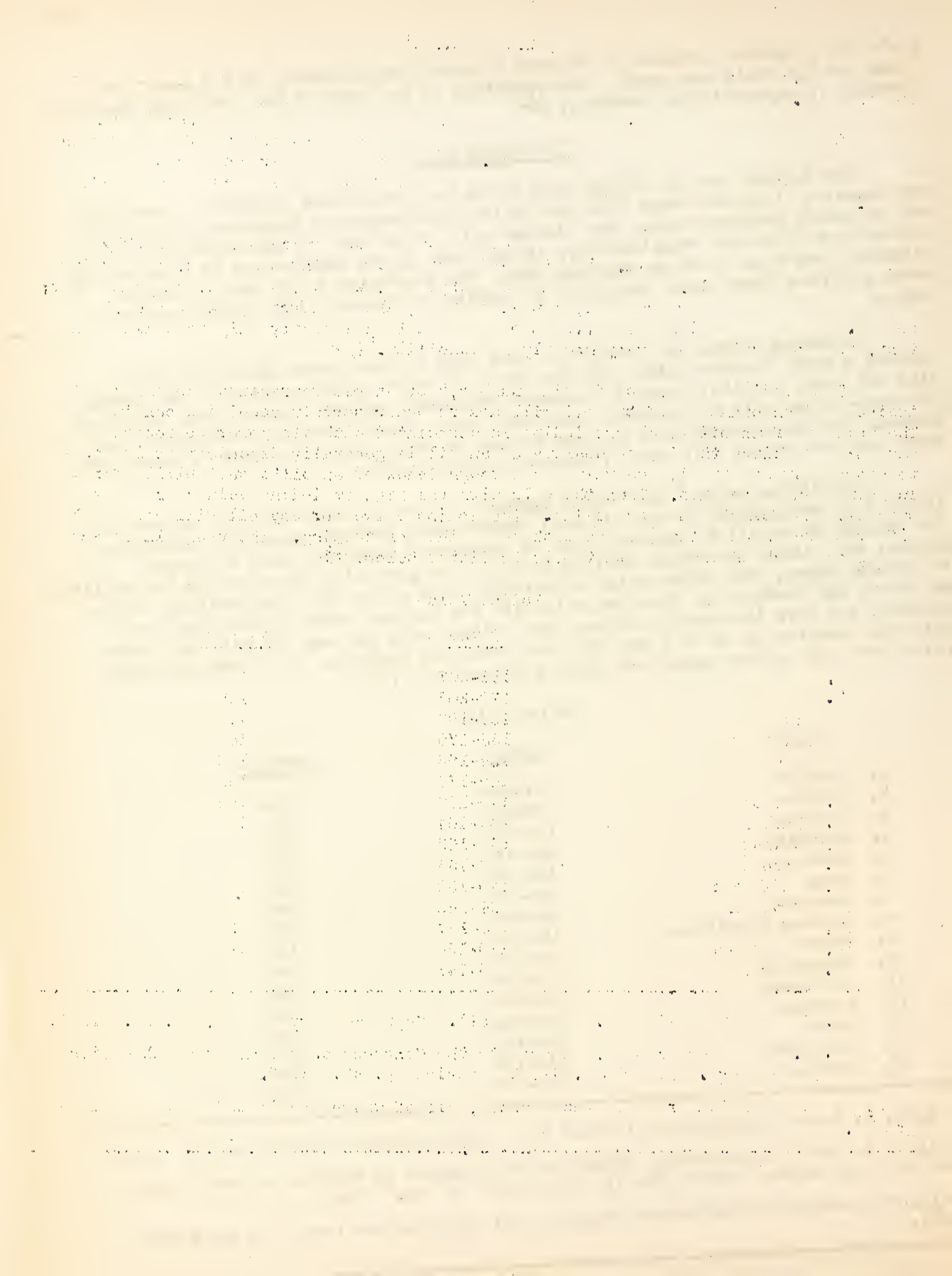
[10] U. S. Tariff Commission. Linseed oil. Supplementary report. p. 21. 1929.

[11] U. S. Tariff Commission. Report to the Congress on certain vegetable oils, whale oil, and copra. Report No. 41, 2nd series, p. 42. 1932.

[12] Data assembled from various sources, all of which are listed in the bibliography.



It should be noted that the low rank of tung oil on the list is due to the fact that the iodine number is not a complete index of that oil's drying qualities. Tung oil dries partly by oxidation, as does linseed oil, but largely by "polymerization," or "spontaneous molecular transformation." 13 The iodine number gives no measure of this factor.

Although all of the oils listed above could be used, at least to some extent, in the paint industry and in other industries using drying oils, it does not follow that all are so used. Some are not produced in sufficient quantities; among these are oiticica oil and walnut oil. Others, such as soybean and sunflower oil, are in greater demand for the manufacture of edible products. Soybean oil is used in the paint industry, but in 1935 only 14 per cent of the domestic utilization of soybean oil was in this industry, whereas 70 per cent of it went into the production of edible products. A very small amount of sunflower-seed oil is used in paints and varnishes, 96 per cent of the domestic utilization in 1935 being in the manufacture of edible products. The increased imports of sunflower oil last year were almost entirely a result of the drought-induced scarcity of edible oils and to the high price of cottonseed oil. With regard to fish oils, by far the largest consumer is the soap industry although a considerable quantity is also used in the drying-oil industries.

The oils which actually compete with linseed oil are, in the order of their 1935 consumption, tung oil, fish oils (sardine and menhaden), perilla oil, soybean oil, and hempseed oil. Oiticica oil has received some notice in the last year, but is still available only in limited quantities. The present duties on these oils just prior to the enactment of the Bailey Amendment 14 and the raw materials from which they are derived are given below. 15

Oils	Duty	Oilseeds	Duty
Linseed	4½ cents per pound	Flaxseed	65 cents per bushel of 56 pounds
Tung	Free	Tung nuts	Free
Perilla	Free	Perilla seed	Free
Soybean	3½ cents per pound but not less than 45 per cent ad valorem	Soybeans	2 cents per pound
Hempseed	1½ cents per pound	Hempseed	Free

Drying oils were not affected by the 1934 excise taxes. There is a tax of 3 cents per pound on imported sardine and menhaden oils, but this does not apply to the products of American fisheries. Sunflower oil, which is used as a drying oil only in very small amounts, is also subject to a tax of 3 cents per pound. As a result of the imposition of this tax in 1934, the consumption of sunflower oil in the paint and varnish industry, already slight, fell more than 50 per cent in 1935, and its consumption in the manufacture of linoleum fell from about 2,000,000 pounds in 1934 to nothing in 1935.

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13 Concannon, C. C. Tung oil. U. S. Dept. Com. Bur. of Foreign and Domestic Commerce. Trade Promotion Series No. 133:44. June, 1932.

14 The provisions of the Bailey Amendment to the Revenue Bill of 1936 in so far as they apply to the above-mentioned oils will be discussed in a later section.

15 U. S. Dept. Agr. Bur. Agr. Econ. Fats and oils, and the excise taxes of 1934. May, 1936.

Linseed Oil

As the oldest known drying oil in occidental countries, linseed oil has become the basic oil in most drying-oil industries. Its many applications and widespread use have given it a prestige in the drying-oil industries which should prevent any very rapid displacement by other oils. In recent years, however, there has been a gradual but steady decline in the relative importance of linseed oil in the drying-oil industries of the United States. This decline has resulted in part from a decrease in the domestic production of flaxseed relative to the demand. The change apparently has been accelerated, however, by improvements in chemical techniques and by the low prices of competing oils. These have provided a considerable incentive for the adaptation of various oils to new uses.

Factory consumption of linseed oil in the paint and varnish industry declined from 75 per cent of the total oil consumption in that industry in 1929 to 57 per cent of the total in 1935 (table 4). In the linoleum and oilcloth industry factory consumption of linseed oil declined from 85 per cent of the total in 1929 to 52 per cent in 1935 (table 5), and the decline in its use in printing inks was from 96 per cent in 1929 to 79 per cent in 1935 (table 6).

The above percentages are for factory consumption. According to estimates made by the Division of Statistical and Historical Research of the United States Bureau of Agricultural Economics, the total consumption of linseed oil, factory and otherwise, declined from 77 per cent of all drying-oil consumption in 1931 to 62 per cent in 1935, with an actual physical decrease in linseed-oil consumption during that period of nearly 50 million pounds.[16] Since the United States grows less than one-half the flaxseed necessary to produce the linseed oil required in her industries, large amounts of foreign flaxseed must be imported in spite of the duty. It is obvious that any oil which can be brought in at a low price will be substituted for linseed oil wherever possible. The duty on linseed oil doubtless stimulated the development of chemical techniques which made cheaper oils available as substitutes. Linseed oil in the past has been adulterated by small quantities of other and cheaper oils, such as soybean, rape, sunflower, safflower, candlenut, and fish oils. If cheaper oils become available which can be mixed with linseed oil or even substituted for it they undoubtedly will be used. This in some degree is what has happened in the last five or six years.

Yearly average prices of linseed oil and competing oils are shown in figure 4. Until 1929, linseed oil was cheaper than most of the other oils. From 1930 to the present time it has averaged much higher in price than any of the other oils, with the exception of tung oil, since 1935.

In spite of the high drying qualities of linseed oil and its general adaptability, it has several disadvantages. The first of these is its tendency to yellow with age, which makes it unsuitable for use in white or transparent enamels and varnishes. Another disadvantage is the difficulty of getting it to combine with synthetic resins, which are cheaper than the imported fossil resins and are becoming increasingly important in the drying-oil industries. Because of this second factor, linseed oil has been largely displaced by tung oil in the varnish field.

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[16] U. S. Dept. Agr. Bur. Agr. Econ. Fats and oils, and the excise taxes of 1934. p. 3.

TABLE 4

Fats and Oils: United States Factory Consumption

in the Manufacture of Paint and Varnish

1929, 1931-1935

Calendar years

Oils	Consumption in thousands of pounds						Consumption in per cent of yearly totals					
	1929	1931	1932	1933	1934	1935	1929	1931	1932	1933	1934	1935
Linseed	340,166	231,608	173,816	192,959	205,743	230,746	75.3	70.5	68.4	64.8	62.4	57.0
Tung	88,386	72,853	59,714	76,714	88,184	98,435	19.6	22.2	23.3	25.8	26.7	24.3
Fish	10,602	12,107	7,565	8,753	11,654	28,951	2.4	3.7	3.0	2.9	3.5	7.2
Perilla	2,573	2,904	3,226	6,529	9,898	27,164	0.6	0.9	1.3	2.2	3.0	6.7
Soybean	5,815	6,256	7,485	8,568	10,451	13,003	1.3	1.9	2.9	2.9	3.2	3.2
Sunflower				175	631	310		0	0	0.1	0.2	0.1
Miscellaneous	4,665	2,662	3,001	3,862	3,333	5,996	0.8	0.8	1.1	1.3	1.0	1.5
Totals	452,207	328,390	254,251	297,560	329,894	404,705	100.0	100.0	100.0	100.0	100.0	100.0

Source of data:

U. S. Dept. Com. Bur. of the Census. Factory consumption of animal and vegetable oil by classes of products. Annual issues.

TABLE 5

Fats and Oils: United States Factory Consumption

in the Manufacture of Linoleum and Oilcloth

1929, 1931-1935

Calendar years

Oils	Consumption in thousands of pounds						Consumption in per cent of yearly totals					
	1929	1931	1932	1933	1934	1935	1929	1931	1932	1933	1934	1935
Linseed	112,855	47,886	32,375	33,015	32,108	41,809	84.8	65.2	56.3	47.2	47.3	51.6
Tung	5,963	7,303	7,299	11,746	12,854	10,391	4.5	9.9	12.7	16.8	19.0	12.8
Fish	10,141	14,837	11,988	13,223	13,282	13,865	7.6	20.2	20.8	18.9	19.6	17.1
Perilla	0	725	1,651	5,826	4,481	9,650	0	1.0	2.9	8.3	6.6	11.9
Soybean	3,229	2,612	4,061	5,641	2,843	4,816	2.4	3.5	7.1	8.1	4.2	5.9
Sunflower				116	1,909		0	0	0	0.2	2.8	0
Miscellaneous	830	130	141	371	334	500	0.7	0.2	0.2	0.5	0.5	0.7
Totals	133,018	73,473	57,515	69,938	67,811	81,031	100.0	100.0	100.0	100.0	100.0	100.0

Source of data:

U. S Dept. Com. Bur. of the Census. Factory consumption of animal and vegetable oils by classes of products. Annual issues.

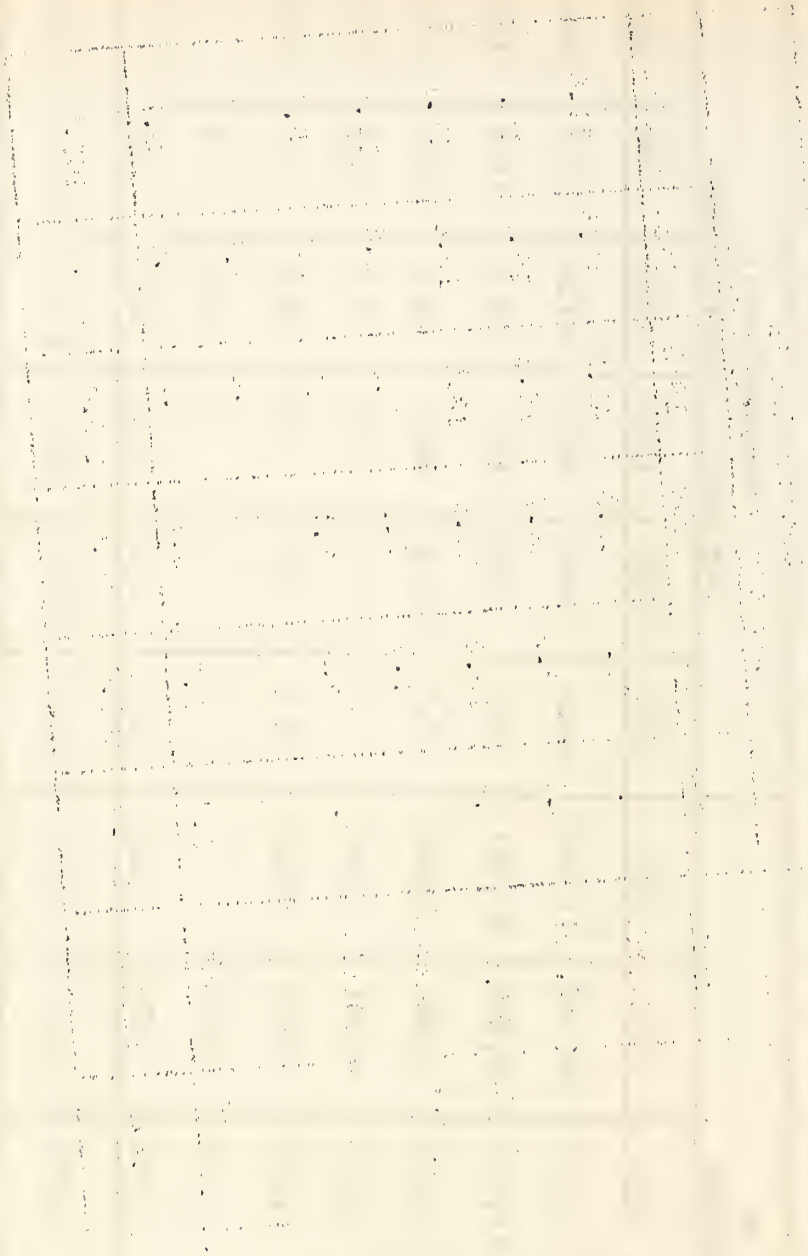


TABLE 6

Fats and Oils: United States Factory Consumption

in the Manufacture of Printing Inks

1929, 1931-1935

Calendar years

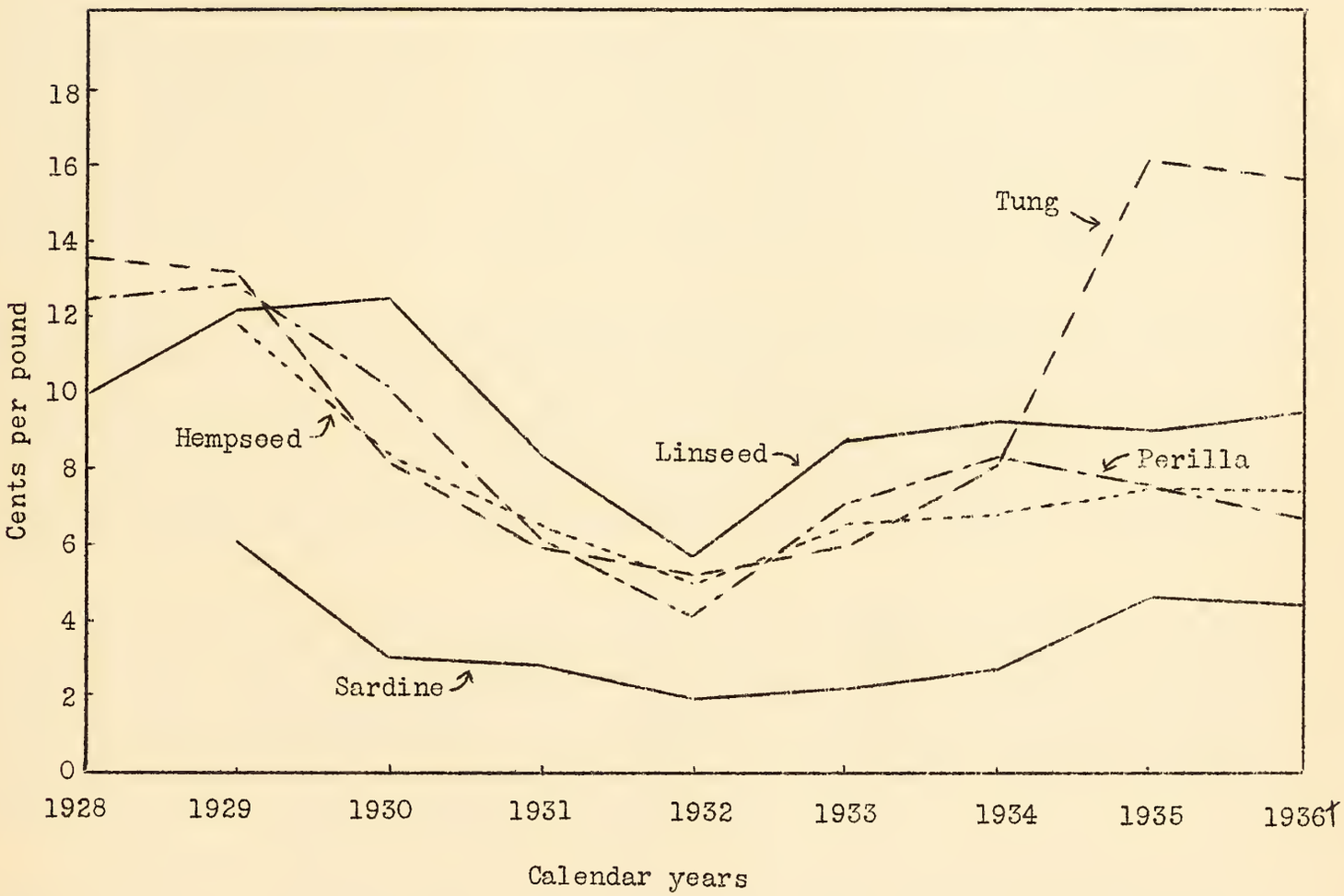
Oils	Consumption in thousands of pounds						Consumption in per cent of yearly totals					
	1929	1931	1932	1933	1934	1935	1929	1931	1932	1933	1934	1935
Linseed	23,894	11,782	9,078	10,863	12,606	14,266	95.8	88.6	87.0	81.0	81.1	79.2
Tung	437	965	713	1,523	1,660	2,013	1.8	7.3	6.8	11.3	10.7	11.2
Fish	50	45	63	113	103	354	0.2	0.3	0.6	0.8	0.7	2.0
Perilla	10	34	143	419	582	828	0	0.3	1.4	3.1	3.7	4.6
Soybean	71	33	47	65	59	52	0.3	0.3	0.5	0.5	0.4	0.3
Sunflower		--	--	--	--	--						
Miscellaneous	488	425	387	436	534	487	1.9	3.2	3.7	3.3	3.4	2.7
Totals	24,950	13,284	10,431	13,419	15,544	18,000	100.0	100.0	100.0	100.0	100.0	100.0

Source of data:

U. S. Dept. Com. Bur. of the Census. Factory consumption of animal and vegetable oils by classes of products. Annual issues.

FIGURE 4

Various Drying Oils: Annual Average
Wholesale Price,* San Francisco, 1928-1936



* Where possible, tank car prices used.

† Five months.

Source of data: Table 10.

Tung Oil

Tung oil, or chinawood oil, is obtained from nuts of the tung tree. Tung oil imports into the United States have been on a steadily rising trend since 1912 as may be seen from figure 5. There has been no tariff on tung oil during this period. Until recently China was the only source of this oil, but in recent years experiments have been made in growing tung trees in the United States, Russia, and various parts of the British Empire. The eagerness of these countries to develop a tung oil supply of their own is an indication of the high esteem in which this oil is held. In the United States one of the earliest attempts to grow tung trees was that of the American Tung Oil Corporation formed in 1923. 17/ The Florida grove of the American Tung Oil Corporation was a failure, but this company's experiments led to the spread of the industry to many of the southern states, and there are at present substantial plantings of tung trees in Florida, Mississippi, Alabama, Louisiana, and Texas, with an estimated total acreage in 1935 of 75,000. 18/ It takes from three to five years, however, for tung trees to begin bearing nuts. 19/ Moreover, it is estimated that 250,000 acres of tung trees would be necessary to supply the present consumption of tung oil. 18/ It seems likely, therefore, that the United States will remain dependent on the Chinese supply for some years to come.

Tung oil is said to be "the best drying and waterproofing oil of vegetable origin known to technical science." 20/ Because of its quick-drying and water-resisting qualities, it is used mainly for making marine and special waterproof varnishes but to some extent for making products in which linseed oil could be used with approximately the same results. Because of its scarcity, tung oil is frequently mixed with other oils, such as linseed, perilla, or oiticica, but this is possible only if waterproof requirements in the varnish are not too rigid. In the oilcloth industry, attempts have been made to substitute mixtures of perilla, sardine and other oils for tung oil.

The high price of tung oil (see figure 4) in ordinary times is, of course, the result of a large demand relative to the supply; European countries competing with the United States for the limited Chinese production. Because of the high and unstable price, the uncertainty of the supply, and the fact that Chinese tung oil is frequently adulterated or of inferior quality, manufacturers have endeavored to keep their requirements as low as possible. There is no doubt, however, that much larger quantities could be consumed if prices were lower.

From 1921 to 1929, the price of tung oil averaged more than 5 cents per pound higher than that of linseed oil. 21/ In September, 1929, the price fell below that

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17/ The fact that this venture was sponsored by the American Paint and Varnish Manufacturers' Association is another indication of the desirability of this oil in the paint industry.

18/ Farm Chemurgic Council. Proceedings of the Tung Oil Conference at Beaumont, Texas. p. 34. October, 1935.

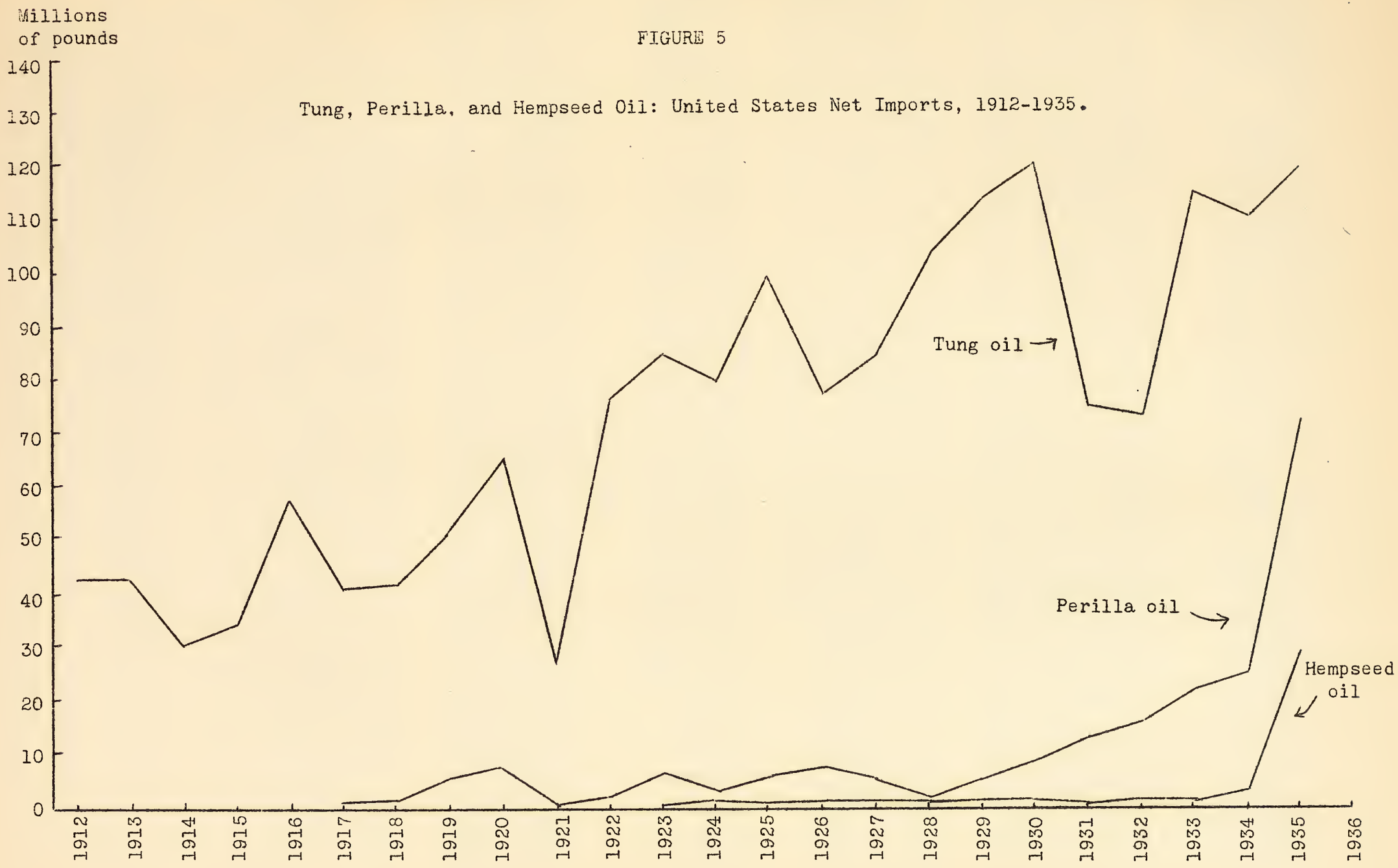
19/ Jamieson, George S. Vegetable fats and oils. p. 270. 1932.

20/ Feiker, F. M. In foreword to Tung oil. U. S. Dept. Com. Bur. of Foreign and Domestic Commerce. p. v. 1932.

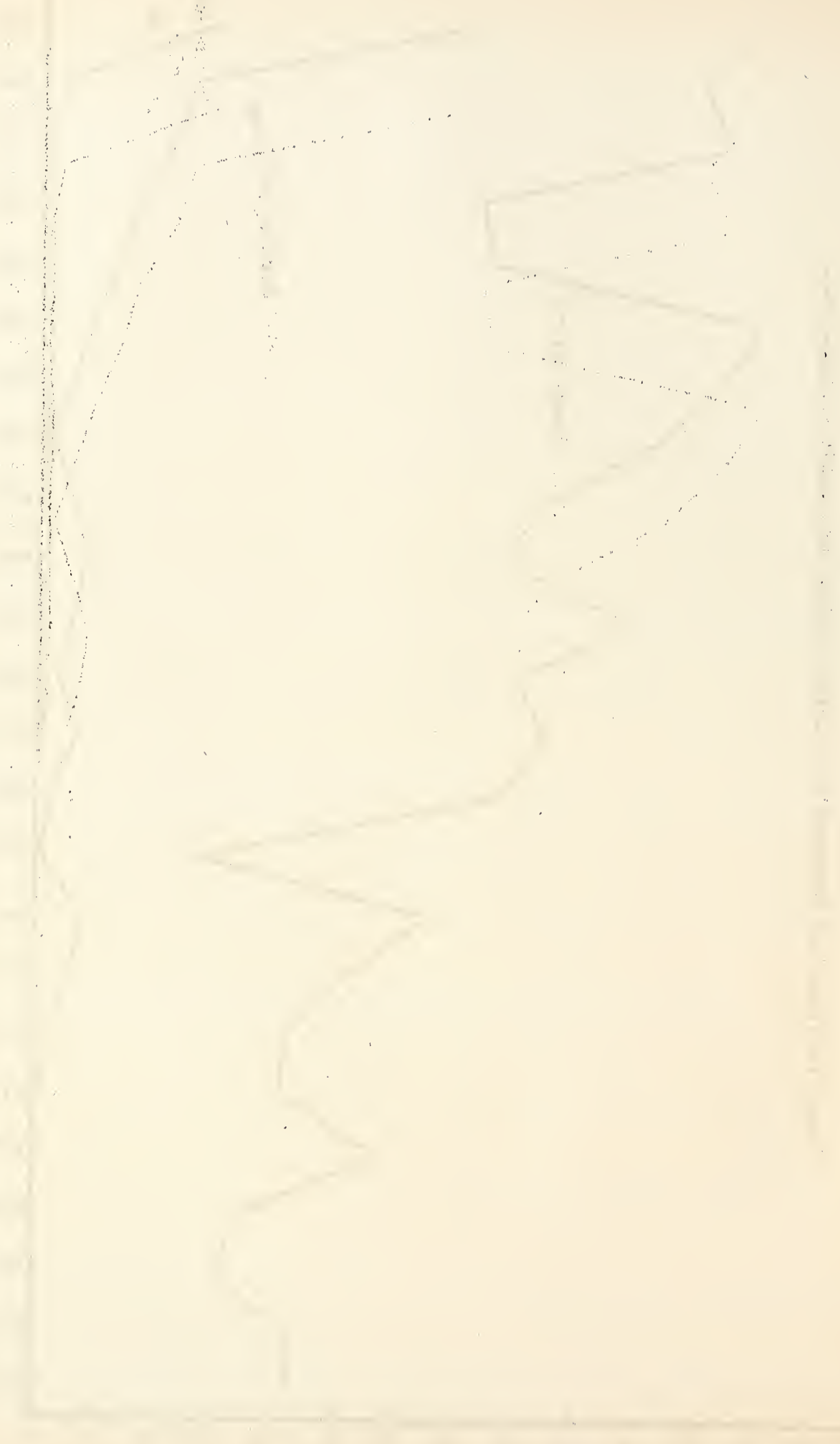
21/ Concannon, C. C. Tung oil. U. S. Dept. Com. Bur. of Foreign and Domestic Commerce. p. 57. 1932.

FIGURE 5

Tung, Perilla, and Hempseed Oil: United States Net Imports, 1912-1935.



Source of data: Table 11.



of linseed oil for the first time in years, and stayed about 2 cents per pound lower on the average until the end of 1934. During 1935 the price began rising steadily, reaching a peak of 35 cents per pound at San Francisco in September of that year. This was the highest since 1923, but a decline soon set in and the San Francisco price has averaged about 15.5 cents in 1936, approximately 6 cents above linseed oil.

The reasons for the decline and subsequent rise in price are several. The disturbed exchange situation between China and the United States, the decreased consumption of drying oils in general, and the relatively large supplies were responsible for the price decline from 1929 to 1932. The rise since 1932 has apparently been a result in part of the changed policy of the United States with respect to silver which has contributed to rising silver prices. The situation has also been affected by a revival of activity in the drying-oil industries and low supplies of tung oil resulting from floods and poor crops in China. The element of speculation was also present in the extremely high prices of September and October, 1935.

Although the short-time fluctuations in tung oil prices have resulted from these many factors, the long-time trend has been influenced by the price of silver. With China using silver as a prominent part of its currency, the world price of silver is an important factor affecting the purchasing power of the dollar in China and the price which must be paid for a Chinese product such as tung oil. Since 1934 silver prices have risen partly as a result of United States federal administration policy and the price of tung oil has also risen.

Low prices from 1930 to 1934 undoubtedly stimulated the consumption of tung oil and its adaptation to new uses, but the rising price in 1935 has not resulted in a decreased consumption, 40 million pounds more being used in that year than in 1931. [22] As already stated, with present technological processes, the increased consumption of tung oil waits only on an increased supply. [23]

Perilla Oil

Although perilla seed is cultivated in northern India, Korea, and Japan, the chief producing country is China, especially the Japanese controlled province of Kwantung in Manchuria. Most of it is crushed at Dairen, a city in that province, or in Japan. Thus China is the biggest producer of perilla seed, but Japan is the chief exporter of the oil, with the United States as her best customer. Experimental plantings of perilla seed have been made in the United States, but so far without commercial success.

Practically unknown in Europe and America before the World War, perilla oil was introduced into world trade because of the high price and scarcity of linseed oil at that time. [24] It has not been important in the drying-oil industries, however, until the last few years. United States imports remained slight until 1929, when they started to increase (see figure 5). Last year imports of over 72 million pounds were recorded, an increase of almost 200 per cent over 1934. The

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[22] U. S. Dept. Agr. Bur. Agr. Econ. Fats and oils, and the excise taxes of 1934. p. 3.

[23] It should be noted that tung meal has not been found suitable for use as a feed. It is being used in the south to fertilize the tung tree groves. Jamieson, George S. Vegetable fats and oils. p. 270. 1932.

[24] Concannon, C. C. Tung oil. U. S. Dept. Com. Bur. of Foreign and Domestic Commerce. p. 53. 1932.

first quarter of this year showed imports almost 200 per cent over the same period last year. In other words perilla oil consumption has increased phenomenally in the last few years and it is the competing oil which has made the most serious inroads in the consumption of linseed oil.

Raw perilla oil is seldom used because of its tendency to dry less smoothly than linseed oil, drops and streaks forming in the film. When heat-treated, however, "it dries in about two-thirds the time for linseed oil," [25] forming a harder and glossier film, but one which discolors more with aging. Because of these characteristics, it is especially adapted to use in certain high-gloss enamels and in varnishes requiring an exceptionally hard film. Its chief use is in combination with other oils of lower drying power, a mixture of perilla and soybean oil, for example, being considered a good paint oil. In some mixtures, perilla may be used as a substitute for tung oil. At present large quantities are also used in linoleum, over 9,500,000 pounds being so used in 1935, compared to less than 750,000 pounds in 1931 and practically none in 1929.

Increased importation and utilization of perilla oil in recent years has been due to larger available supplies and to lower prices (see figure 4). Until 1929 the price of perilla oil was generally higher than that of linseed oil, averaging 3.5 cents per pound higher from 1926 to 1929. From 1930 to date, its price has remained below that of linseed oil, averaging more than 1.5 cents less. With the exception of sardine and other fish oils, perilla has in recent months been the cheapest of the paint oils.

Increased supplies available for consumption in the United States have resulted partly from larger crops of seed and partly from decreased European and Oriental demand. "The demand for perilla oil in the Orient has been largely displaced by linseed oil produced from Indian flaxseed," [26] and the European demand has also fallen off, leaving the United States as the principal market. In addition to increased supplies, the fall in price has been accelerated by depreciated exchange rates for the Japanese yen. Shortly after England abandoned the gold standard, in September, 1931, Japan followed suit, the yen falling steadily from its par value of 50 cents to 21 cents by November, 1932. Thus, by the latter date, the cost of Japanese goods in terms of dollars was less than half what it had been previously. This helps to explain the fact that the price of perilla oil fell even lower in 1932 than other vegetable oils. The fact that the United States in turn abandoned gold in 1933, and later devalued the dollar, making the yen more valuable in terms of dollars, helps to account for the somewhat higher prices of perilla oil in the years after 1932. The yen is still depreciated, however, being worth about 29 cents at present. [27]

Until recently no perilla seed was crushed in the United States. This was mainly because of the fact that the oil cake has not been considered suitable for

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[25] Concannon, C. C. Tung oil. U. S. Dept. Com. Bur. of Foreign and Domestic Commerce. p. 54. 1932.

[26] U. S. Tariff Commission. Report to the Congress on certain vegetable oils, whale oil, and copra. p. 110. 1932.

[27] The new excise tax (established by the Bailey Amendment) of 4.5 cents a pound on perilla oil and 2 cents a pound on perilla seed will probably offset the effect of the depreciated yen.

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cattle feed.[28] Nevertheless, last year a little less than 3 million pounds of seed were imported and crushed at San Francisco, the meal being used as a dairy feed in northern California.

Hempseed Oil

The Manchurian province of Kwantung, the principal source of perilla seed, is also the chief source of hempseed imports into the United States, although smaller amounts come from Japan and China proper. In the Orient hempseed oil is used in the production of edible products, but in the United States it is used as a paint oil. Because of the tariff of 1.5 cents per pound on the oil, most of the imports have been in the form of seed, which was free of duty until enactment of the Revenue Act of 1936. Hempseed is largely crushed on the Pacific Coast.

Tung and perilla oils have higher drying powers than linseed oil. Hempseed oil, on the other hand, is of lower drying power. Although its drying time is thus somewhat slower it is reputed to give results very similar to linseed oil when used in paints, and is considered by some dealers as the equivalent of linseed oil. It is also used to some extent in linoleum.

Imports of hempseed remained negligible until 1935 (see figure 5). In that year over 116 million pounds were imported, and imports during the first quarter of 1936 have been 66 per cent greater than for the same period in 1935. The chief factor in this increase is the low price (see figure 4). During the first five months of 1936 hempseed oil averaged over 2 cents per pound less than linseed oil, and from 1932 to date it has averaged 1.8 cents less. Since the Manchurian exchanges have been pegged to those of Japan in recent months, the price of hempseed is affected by the depreciated Japanese exchange rates in the same manner as perilla oil. This helps to explain why the prices of perilla and hempseed oil have been lower than those of other vegetable drying oils.

Some Pacific Coast crushers reported unsatisfactory experience with hempseed last year, the oil yield being only 25 per cent and the moisture content being too high as a result of the floods and wet season in the Orient. These disadvantages, however, were balanced by the merits of hempseed oil as a substitute for linseed oil.

Hempseed meal is inferior as a feed to linseed meal but is sold on the basis of its lower price. The current price is reported to be around $26.00 per ton, whereas linseed meal in California currently sells at from $34.00 to $38.00 per ton.

Soybean Oil

Imports of soybean oil in the past have been large (see figure 5), but are now negligible, because of increased domestic production. Production of soybeans has increased greatly in the United States, the increased supplies going mostly into food uses. The use of soybean oil in the drying-oil industries is reported, however, to have increased 50 per cent, from 12 million pounds in 1932 to 18 million pounds in 1935.[29]

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[28] In Japan the cake is used as a fertilizer for mulberry trees. U. S. Tariff Commission. Report to the Congress on certain vegetable oils, whale oil, and copra. p. 28. 1932.

[29] U. S. Dept. Agr. Bur. Agr. Econ. Fats and oils, and the excise taxes of 1934. p. 3. 1934.

Because of its low drying ability soybean oil is used chiefly in combination with other oils. Mixed with perilla, large quantities are used in paints, and some paint makers use from 10 to 15 per cent of boiled soybean oil to mix with linseed. 30/ Recently, it has been used in automobile enamels, and small amounts are employed in the manufacture of linoleum. Soybean oil possesses one advantage over linseed oil in the fact that paints made from it do not yellow with age. For this reason it is frequently employed in making "white or pale-colored enamel paints for interior use." 30/

Recently soybean oil has averaged about one-half a cent per pound higher in price than linseed oil (see figure 4), probably because of the increased demand for it in the manufacture of edible products. As a result of the scarcity of other edible oils, its use in this field was 60 million pounds greater in 1935 than in 1934. Even from 1931 to 1934, when soybean oil averaged almost 2 cents less per pound than linseed, the increase in consumption was relatively small. This is probably accounted for by its low drying power, which sets a limit to the amount used.

For the protection of American producers, mainly in the Middle West, there has been a tariff since 1930 of 2 cents per pound on soybeans, and 3.5 cents per pound on soybean oil.

Oiticica Oil

This oil is obtained from the nut of the oiticica tree, which grows wild in northeastern Brazil. About 2 million pounds 31/ of it were imported in 1935 as a substitute for tung oil (see figure 5). The high price of the latter, at that time, stimulated the search for substitutes and focused attention on oiticica oil. Although a certain amount of this oil may be substituted for tung oil with good results, latest experiments indicate that it is not as good for general use. 31/ During the thirteen months for which quotations are available oiticica oil has been consistently higher in price than linseed oil and lower than tung oil (see figure 4). It thus competes with the latter rather than the former. Although imports for 1936 may be larger than for 1935, the supply will be limited for the next few years.

Other Vegetable Oils

Small quantities of minor drying oils are also consumed, frequently mixed with linseed oil but sometimes in special uses of their own. For example, the oil from culled walnuts is used in some high-grade enamels, "while grapeseed or raisin oil ....is used in paints requiring flexibility such as the painting of canvas awnings and chair coverings." 32/

Fish Oils

The soap industry is the largest consumer of fish oils, but large amounts are also used in the drying-oil industries. Some fish oils, notably sardine and menhaden, have iodine numbers almost as high as that of linseed oil and are sometimes used as substitutes, especially when the price of linseed oil is high.

30/ Jamieson, George S. Vegetable fats and oils. p. 261. 1932.

31/ Oil, Paint, and Drug Reporter. Oiticica oil: a possible substitute for wood oil. p. 53. November 14, 1935.

32/ Smith, Paul X. Animal and vegetable oils. Chemical and Metallurgical Engineering. p. 437. August, 1935.

Menhaden oil, produced on the Atlantic Coast, has been the most important fish oil in the drying-oil industries, but its production trend has been downward whereas sardine, herring, and pilchard oils have been gaining in importance as drying oils of marine origin.[33] On the Pacific Coast, there are 40 plants producing fish oils, the most important drying oil being sardine oil.[34]

Because of its odor fish oil has been used only in the poorer grades of outside paints, but chemists are seeking with good prospects of success to eliminate the odor. If the characteristic odor of fish oil is eliminated it will be a strong competitor of linseed oil because of its cheapness. The consumption of fish oil is always limited, however, by the size of the annual fish catch, and there is a possibility that the supply of sardines and other fish may be depleted in the future.

As shown in figure 4, the price of sardine oil on the Pacific Coast has since 1929 been considerably lower than that of any vegetable oil used in paints. Thus far in 1936 it has averaged over 2 cents per pound less than perilla and over 5 cents less than linseed.

Approximately 29 million pounds of fish oil were used in paints and varnishes in 1935 compared to 12 million pounds in 1931 and 11 million pounds in 1929. In the manufacture of linoleum and oilcloth, 14 million pounds were used in 1935, but there was no marked increase over previous years.

An excise tax of 3 cents per pound on fish oils applies only to imported fish oils.

Competition of Other Drying Oils with Linseed Oil

The interchangeability of drying oils is dependent on (1) their physical or chemical properties, (2) their adaptability for similar purposes, (3) their availability from domestic or foreign sources, and (4) their relative prices.[35]

The depression greatly curtailed the demand for drying oils, the low point being in 1932. Since then demand has steadily revived, helped along by revival in the construction and automobile industries which are important consumers of paints, varnishes, and enamels. With the revival, however, came a relative decrease in the use of linseed oil and increasing imports and consumption of other drying oils.

The reasons for this are several, the most important being the low prices of other oils compared to linseed. The reasons for these low prices have been discussed previously. The gradually widening field for the utilization of competing oils as a result of experimentation and discovery of new techniques is another important factor. Decreased demand for such oils outside of the United States also played a part. For example, during 1935 Germany obtained large quantities of whale oil, and the German government ordered the seed crushers not to import any more seeds for the time being.[36] Finally the downward trend (since 1924) in the United

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[33] Concannon, C. C. Tung oil. U. S. Dept. Com. Bur. of Foreign and Domestic Commerce. p. 53. 1932.

[34] Smith, Paul X. Animal and vegetable oils. Chemical and Metallurgical Engineering. p. 437. August, 1935.

[35] Concannon, C. C. Tung oil. U. S. Dept. Com. Bur. of Foreign and Domestic Commerce. p. 50. 1932.

[36] U. S. Dept. Com. Bur. of Foreign and Domestic Commerce. Foodstuffs 'round the world: meats, livestock, fats and oils. May 19, 1936.

States production of flaxseed, accompanied by increased supplies of other oil-bearing seeds, has contributed to the displacement of linseed oil in the drying-oil industry.

Generally speaking, part of the consumption of each of the oils discussed is in fields to which it is specially adapted and superior to linseed oil. In such uses it would be undesirable to attempt to force the use of linseed oil. In part, however, each of the oils has been used merely as a cheaper substitute for linseed oil. This applies even to tung oil during the period when its price was very low.

In so far as other oils are interchangeable with linseed there seems to be no reason for treating them differently and, since there is a tariff on flaxseed and linseed oil, it would seem reasonable to have a corresponding tariff on interchangeable oils. It would be undesirable, however, if such a tariff caused the impairment of the quality of American products by eliminating an oil from some use to which it is better adapted than any other oil.

The widespread demand for tung oil and its limited supply will ordinarily keep its price above that of linseed oil. Consequently a tariff on tung oil would seem to be not only undesirable but unnecessary; as it would serve only to increase the cost or lower the quality of products in which tung oil contributes to a higher quality.

Perilla oil has been the most severe competitor of linseed oil in recent years, though hempseed oil has also been coming to the fore as a substitute for linseed oil. It would seem that a tariff on these oils equivalent to that on linseed is justified. The fact that their low prices have resulted partly from the depreciation of the Japanese yen strengthens the argument for protection.

Soybean oil and fish oils are largely domestic products. There is already a tariff on imported soybean oil and an excise tax on foreign fish oils.

The Bailey Amendment

An amendment to the Revenue Act of 1936, recently enacted by Congress, was introduced by Senator Bailey of North Carolina in the Senate Finance Committee. In the original amendment a tax was placed on tung, perilla, and hempseed oils, and on the raw materials from which they are expressed. Tung oil was later eliminated. Soybean growers objected to the inclusion of perilla oil under the tax provisions of the bill on the ground that the use of soybean oil in paints was largely dependent on the availability of perilla oil to mix with it. Perilla oil was first eliminated, and later put back in. A proposed amendment which was not adopted would have placed a tax on fish oils produced by the "floating reduction plants," that is, on fish oil produced at sea to avoid state regulation. As finally passed, the bill provides for a tax of 4.5 cents per pound on perilla and hempseed oils and a tax of 2 cents per pound on perilla seed and hempseed. It goes into effect on August 22, sixty days after signature by the President (June 23).

The tax on these oils is the same as the tariff on linseed oil, 4.5 cents per pound. As previously stated, however, there is a differential in favor of flaxseed, which prevents the importation of very much linseed oil. The tax of 2 cents per pound on perilla seed is equivalent to a tax of approximately 5.4 cents per pound on the oil yield of about 37 per cent. In the case of hempseed, the tax of 2 cents on the seed is equivalent to one of about 8.3 cents per pound on the oil yield of around 24 per cent. Clearly, in these two cases, it will pay to import the oil rather than the oil seeds. Imports of perilla and hempseed oils bearing the 4.5 cents a pound tax will compete with imports of flaxseed on which the tariff of 65 cents a bushel is equivalent to 3.5 cents a pound on the oil content with the

further advantage of the drawback on the export of the oil cake. Flaxseed therefore has an advantage of more than 1 cent per pound over the other oils. It is probable, however, that this advantage about counterbalances Japan's advantage derived from her depreciated exchanges.

It is not likely that these taxes will prevent imports of perilla and hempseed oil. Their consumption may decrease together with that of soybean oil for drying-oil purposes since soybean oil for this purpose is largely used in combination with perilla. The result of this tendency will be a larger consumption of foreign flaxseed or other drying oils except as United States production of flaxseed increases. The fact that the bill favors the importation of oils rather than seeds may help to reduce the over-supply of dairy feeds, particularly in California where hempseed and perilla seed have hitherto been crushed.

Conclusions with Reference to California

According to trade estimates the annual California consumption of linseed oil at the present time is about 24,000,000 pounds, or roughly the equivalent of 1,250,000 bushels of flaxseed. The total United States consumption of linseed oil in 1935 was 424,000,000 pounds which is equivalent to 22,714,000 bushels of flaxseed. California consumption, therefore, is about 5.5 per cent of that for the nation. In 1935 California's production of 570,000 bushels was 4.0 per cent of the United States crop of 14,123,000 bushels.

The United States uses more flaxseed than it produces. This is true of California to a greater extent than for the country as a whole. In the ten years ending with 1935, 52 per cent of the linseed oil in the United States came from abroad. For California in 1935 about 54.4 per cent of the linseed oil used came from out of the state. More than twice the local 1935 production would be needed to cover California's consumption requirements. This deficit is made up at present by shipments from outside California, chiefly from the middlewestern states. In filling these requirements, California flax growers have the protection, in addition to the tariff, of an 85 cent per hundredweight rail freight rate on linseed oil shipped here from Minneapolis. This freight rate on linseed oil is equivalent to $0.16 per bushel of flaxseed. This means that it costs $0.16 to transport to California the linseed oil which can be produced here from one bushel of flaxseed. If California's flaxseed industry were to expand to the point where this became a surplus instead of a deficit linseed oil area, this freight rate advantage would disappear.[37]

Although exact figures are not available, it appears probable that the competing oils have been used more extensively in California, relative to linseed oil, than in the country as a whole. Because of their geographical position with reference to the Orient, San Francisco and Los Angeles are important ports of entry for these competing oils. Savings in freight rates tend to encourage the utilization of imported oils near their ports of entry.

Despite the imposition of the new excise taxes, the competing oils will still be utilized to some advantage on the Pacific Coast, especially in California; but the operation of the excise taxes imposed by the Revenue Act of 1936 will probably lead to considerable replacement of these with linseed oil in California as well as in other parts of the United States.

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[37] As stated earlier this paper does not undertake to indicate the feasibility or infeasibility of expanding further the California flax industry from the standpoint of technical possibilities. That is a problem of soils, competing crops, climate, varieties, etc., which will require further study and experimentation.

TABLE 7

Fats and Oils: United States Factory Consumption in the Manufacture of Paint and Varnish, Linoleum and Oilcloth, and Printing Ink

1929, 1931-1935

Calendar years

Oils	Consumption in thousands of pounds						Consumption in per cent of yearly totals					
	1929	1931	1932	1933	1934	1935	1929	1931	1932	1933	1934	1935
Linseed	476,915	291,276	215,269	236,837	250,457	286,821	78.2	70.2	66.8	62.2	60.6	56.9
Tung	94,786	81,121	67,170	89,983	102,698	110,839	15.5	19.5	20.8	23.6	24.9	22.0
Fish	20,793	26,989	19,616	22,089	25,039	43,170	3.4	6.5	6.1	5.8	6.1	8.6
Perilla	2,583	3,663	5,020	12,774	14,961	37,642	0.4	0.9	1.6	3.4	3.6	7.5
Soybean	9,115	8,901	11,593	14,274	13,353	17,871	1.5	2.1	3.6	3.7	3.2	3.5
Sunflower				291	2,540	310		0	0	0.1	0.6	0.1
Miscellaneous	5,983	3,217	3,529	4,669	4,201	6,983	1.0	0.8	1.1	1.2	1.0	1.4
Totals	610,175	415,147	322,197	380,917	413,249	503,736	100.0	100.0	100.0	100.0	100.0	100.0

Source of data:

U. S. Dept. Com. Bur. of the Census. Factory consumption of animal and vegetable fats and oils by classes of products, 1929 and 1931-1935. Annual issues.

TABLE 8

Flaxseed: United States Production and Net Imports of Flaxseed and Linseed Oil in Terms of Seed*
(Thousand bushels)

Crop years†	Production	Net imports (+) or net exports (-)	Totals	Crop years	Production	Net imports (+) or net exports (-)	Totals
1889-1890	10,250	+ 2,347	12,597	1919-1920	6,770	+26,016	32,786
1899-1900	19,979	- 2,716	17,263	1920-1921	10,900	+15,955	26,855
1902-1903	29,285	- 4,064	25,221	1921-1922	8,107	+23,240	31,347
1903-1904	27,301	- 671	26,630	1922-1923	10,520	+28,848	39,368
1904-1905	23,401	+ 191	23,592	1923-1924	16,563	+19,412	35,975
1905-1906	28,478	- 6,048	22,430	1924-1925	31,220	+12,725	43,945
1906-1907	25,576	- 6,422	19,154	1925-1926	22,334	+20,710	43,044
1907-1908	25,851	- 4,374	21,477	1926-1927	18,531	+24,043	42,574
1908-1909	25,805	- 387	25,418	1927-1928	25,174	+18,057	43,231
1909-1910	19,699	+ 5,922	25,621	1928-1929	19,118	+23,505	42,623
1910-1911	12,718	+11,937	24,655	1929-1930	15,924	+18,428	34,352
1911-1912	19,370	+ 7,722	27,092	1930-1931	21,673	+ 9,869	31,542
1912-1913	28,073	+ 2,948	31,021	1931-1932	11,755	+10,903	22,658
1913-1914	17,853	+ 9,556	27,409	1932-1933	11,511	+ 9,375	20,886
1914-1915	13,749	+12,158	25,907	1933-1934	6,904	+16,768	23,672
1915-1916	14,030	+14,128	28,158	1934-1935	5,661	+17,289	22,950
1916-1917	14,296	+10,439	24,735	1935-1936	14,213	+18,758 ‡	32,971
1917-1918	9,164	+13,575	22,739	1936-1937	6,342 ♀		
1918-1919	13,369	+ 8,748	22,117				

* Linseed oil in terms of seed on the basis 18.75 pounds of oil equivalent to 1 bushel of seed.

† Net imports up to 1908-09 are for the year July to June; beginning in 1909-10, they are for the year, September to August.

‡ 1935-36 net imports -- estimated on the basis of the first six months from the monthly summary of foreign commerce of the United States.

♀ U. S. Dept. Agr. Bur. Agr. Econ. Crop Reporting Board. General crop report as of August 1.

Sources of data:

1889-90 to 1908-09: U. S. Dept. Agr. Yearbook 1927.

1909-10 to 1934-35: U. S. Dept. Agr. Yearbook 1935. Production data, 1924-25 to 1935-36. U. S. Dept. Agr. Bur. Agr. Econ. Crop Reporting Board. General Crop Revisions Crop Years 1924-1935. June, 1936. (Mimeo.)

1934-35 net imports: U. S. Dept. Com. Bur. For. Dom. Com. Monthly summary of foreign commerce of the United States.

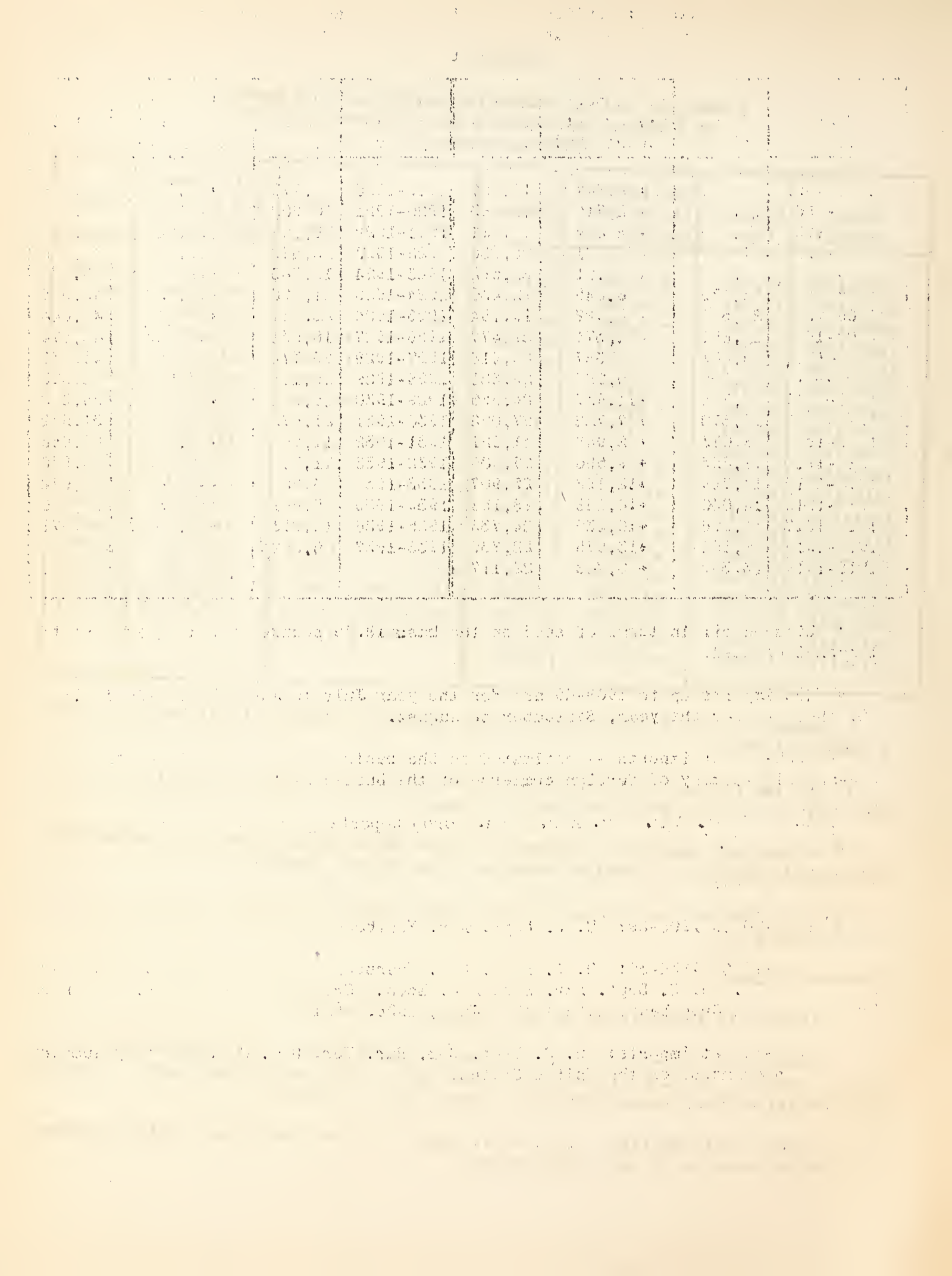


TABLE 9

Linseed Oil: United States Net Imports

or Net Exports, 1912-1935

(Thousand pounds)

Calendar year	Net imports	Net exports	Calendar year	Net imports	Net exports
1912		1,017	1924	10,860	
1913		10,718	1925	11,120	
1914	2,355		1926	12,474	
1915		9,382	1927		1,579
1916		5,469	1928		1,792
1917		10,852	1929	7,753	
1918		5,610	1930	533	
1919	4,824		1931		859
1920	29,833		1932		817
1921	56,574		1933	10,429	
1922	141,434		1934	2,113	
1923	40,084		1935	1,247	

Sources of data:

1912-1933: U. S. Dept. Agr. Bur. Agr. Econ. Division of Statistical and Historical Research. Fats and oils: statistics of United States production, trade, and consumption, 1912-1933. March 1, 1934.

1934-1935: U. S. Dept. Com. Bur. of the Census. Animal and vegetable fats and oils. Quarterly numbers.

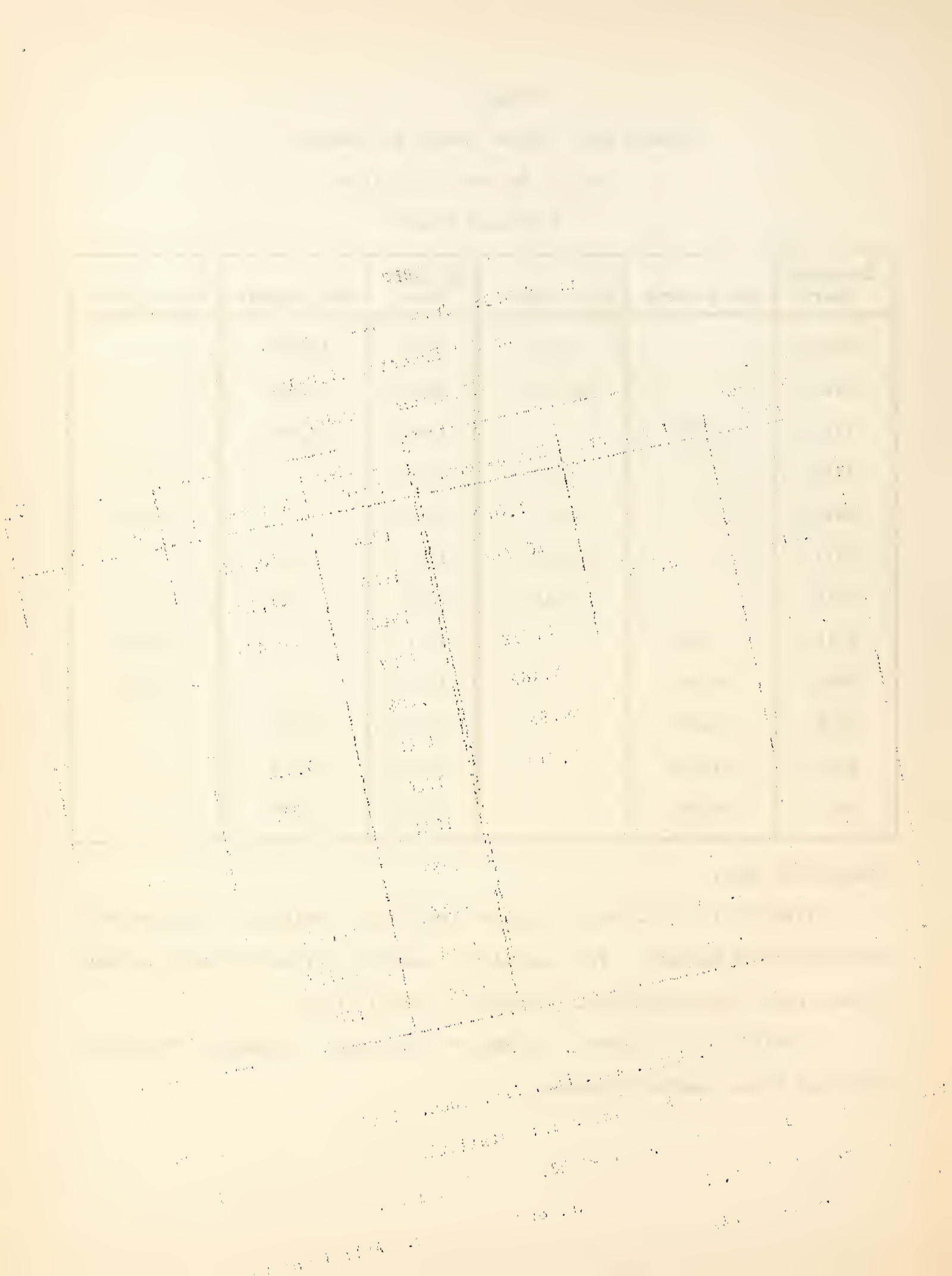


TABLE 10

Various Drying Oils: Annual Average Prices, San Francisco

1928-1936

(Cents per pound)

Calendar year	Linseed	Tung	Perilla	Hempseed	Soybean	Sardine	Oiticica
1928	10.0*	13.6	12.5				
1929	12.2*	13.2	12.9	11.8	10.4	6.1	
1930	12.5*	8.2	10.1	8.4	8.9	3.0	
1931	8.4*	5.9	6.1	6.5	6.7	2.8	
1932	5.7	5.2	4.1	5.0	4.8	1.9	
1933	8.7	5.9	7.1	6.5	6.3	2.2	
1934	9.2	8.1	8.3	6.8	6.9	2.7	
1935	9.0	16.1	7.6	7.5	9.5	4.6	16.1*†
1936 ‡	9.5	15.6	6.7	7.4	9.9	4.4	12.8*

* New York price.

† Last eight months.

‡ First five months.

Source of data:

Compiled from Oil, Paint, and Drug Reporter. Weekly issues.

TABLE 11

Various Drying Oils: United States Net Imports
1912-1936
(Thousand pounds)

Calendar year	Tung oil	Perilla oil	Soybean oil	Hempseed	Hempseed as oil*	Calendar year	Tung oil	Perilla oil	Soybean oil	Hempseed	Hempseed as oil*
1912	42,707		24,775			1926	77,425	7,401	28,600	4,622	1,155
1913	42,405	76	14,185			1927	84,363	5,358	8,287	4,256	1,064
1914	30,031	42	12,552			1928	103,036	2,011	5,122	4,242	1,061
1915	33,867	79	21,259			1929	113,487	5,574	11,393	5,847	1,462
1916	57,517	168	143,346			1930	120,064	8,838	2,869	5,394	1,349
1917	40,847	976	260,949			1931	74,668	13,286	- 533†	3,596	899
1918	41,613	922	335,439			1932	72,594	16,525	-2,228	6,375	1,594
1919	51,360	4,743	150,260	3,108	777	1933	114,524	22,776	2,100	4,538	1,135
1920	65,079	7,582	65,474	6,036	1,509	1934	109,787	25,164	788	12,981	3,245
1921	26,430	652	14,828	1,142	285	1935	120,059	72,328	10,137	116,682	29,171
1922	76,386	2,208	14,417	4,180	1,045	First					
1923	83,829	6,441	40,151	2,558	640	quarter					
1924	79,375	3,016	6,584	4,523	1,131	1935	26,541	10,681	2,188	23,059	5,765
1925	98,987	6,017	17,225	4,018	1,005	First					
						quarter					
						1936	42,123	30,686	1,237	38,282	9,571

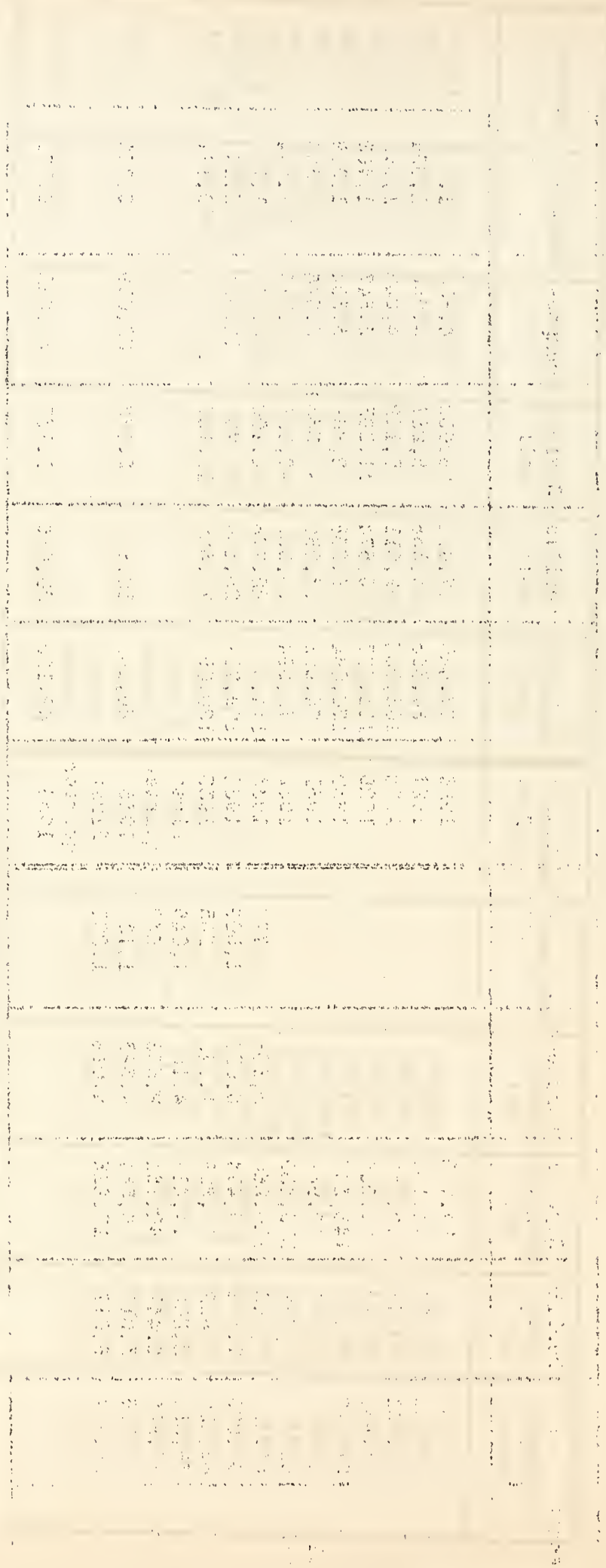
* On the basis of 25 per cent oil yield from hempseed.

† Net exports.

Sources of data:

1912-1933: U. S. Dept. Agr. Bur. Agr. Econ. Division of Statistical and Historical Research. Fats and oils: statistics of United States production, trade, and consumption, 1912-1933.

1934-1936: U. S. Dept. Com. Bur. For. Dom. Com. Monthly summary of foreign commerce of the United States.



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